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13. ABSTRACT (Maximum 200 Words)  We have established a three-phase training program to motivate talented undergraduate students, especially students from under-represented Southwestern minorities, to pursue careers in breast cancer research. Phase I provides a well-rounded introduction to the theory and practice of breast cancer research. This phase includes inquiry-based tutorials that integrate key concepts in normal and cancer breast biology; visits to specialized laboratories that utilize state-of-the-art technologies for breast cancer research; structured interactions with surgeons, medical oncologists and their patients, radiologists and pathologists in settings that introduce the clinical realities of breast cancer diagnosis and treatment; seminars presented by the Program's research mentors; a weekly, journal club that introduces current issues in breast cancer research while developing presentation and critical reading skills and a research project supervised by one of the program's mentors. During phases II and III, trainees have opportunities to continue their research projects throughout their senior years, and then in graduate school, respectively. The success of the program will be evaluated in the short term by the satisfaction of the trainees and mentors, and in the longer term by the number of trainees that goes on to graduate studies in breast cancer-related programs.			
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## **Introduction**

The objective of the *University of New Mexico Undergraduate Breast Cancer Training Program: Pathway to Research Careers* training program is to encourage and motivate undergraduate students, especially underrepresented Southwestern minority and students, to pursue science careers related to breast cancer research. The **specific aim** is to establish a structured, well-rounded training program that provides experiences, tools, knowledge and motivation to pursue careers in breast cancer research. This report identifies the accomplishments and outcomes of the second year of this training program

## **Body**

The training plan was divided into three phases. The first phase consisted of an intensive summer training program in which trainees were introduced to the basic molecular concepts necessary for understanding breast cancer biology. In addition, students were provided with an introduction to research practice, and the ethical issues related to research. Students also had an opportunity to talk with patients, view surgeries and visit state-of-the-art service laboratories in addition to beginning their individual research projects in the laboratory of a funded breast cancer investigator. Phases II and III, which are fully supported by the Department of Biochemistry, allow students to progress through their Bachelor's degree and matriculate into graduate or professional school.

The first cadre of 7 students has completed all three phases of the program and have applied to graduate and professional schools. Of these 7 students, 4 were supported by this training grant and 3 were supported by the Department of Biochemistry and Molecular Biology. Due to health issues one of the students did not complete the program. Of the remaining 6 students, one is currently a senior in the Biology Department and she is continuing her research. All of the remaining student either have graduated or will graduate following the spring 2004 semester. This coming fall, two students will begin the graduate program at Duke University, one student will enter the Biomedical Sciences Graduate program at the University of New Mexico and the remaining two students have applied to medical school. During phases II and III in this program, the students in this group remained very active and involved with their research projects. Their projects were presented at both national and local meetings. In addition, as the public service component of the project, the group organized the Undergraduate Biomedical Research Association as an official student organization at the University of New Mexico.

The second cadre of 6 students is currently in phase II of the program. Of these students 5 are still actively involved in the program. The sixth student has applied to the Doctor of Pharmacy program at the University of New Mexico and her acceptance into that program is pending. If accepted into the program, she will not be able to complete phases II and III of the pathways program.

The third cadre of students has recently been notified of their acceptance into the program and will begin phase I this summer. It should be noted that the population of students was decreased this year because the department could not support the additional students.

The annual progress on the training program will be reviewed in the context of the 8 Objectives of the original "Statement of Work".

**Objective 1: Identify and recruit four sophomore and junior undergraduate students from the University of New Mexico, including women and minority students, to participate in the summer training program.**

Recruiting was limited to the University of New Mexico. Recruiting materials were circulated in introductory science classes and a description of the program was available on a web site dedicated to the "Pathways" Program. This web site obtains approximately 45,000 hits per month. A copy of the current advertising brochure is appended to this report. The demographics of all three classes are shown in Table 1.

**Table 1 Demographics of Pathways Participants**

Classification	Summer 2002	Summer 2003	Summer 2004
Gender	Female: 4 Male: 3	Female: 5 Male: 1	Female: 4 Male: 0
Minority	2	4	3
Average years of college	2.5	2.5	
Biochemistry majors	3	1	
Number completing phase I	6	6	NA
Number continuing in, or completing phase III	6	5	NA
Number applying to medical school or graduate school	5	NA	NA

It was judged that the method of recruiting was successful and a similar procedure has been implemented for all years of the program.

**Objective 2: Provide Trainees a broad understanding of the basic concepts necessary to understand breast cancer biology and treatment.**

During the first year, a set of 6 inquiry-based training cases was developed to introduce students to the concepts and vocabulary associated with breast cancer research and biology. Not only did the cases raise important biological issues, but the students also addressed issues related to research ethics and patient behaviors. During the initial tutorial sessions it was discovered that the students need an opportunity to begin designing experiments, asking experimental questions, and to practice oral presentation skills. Consequently each of the cases was amended to include these training opportunities. Student feedback was extremely positive and the same cases were used in year 2 and will be used in year 3 of the program. A list of tutorial cases, case objectives and the schedule for the pathways program has been included in the appendix.

**Objective 3: Provide Trainees familiarity with state-of-the-art breast cancer research technologies.**

Tutorial cases included reference to and data obtained from modern research technologies. At the appropriate time in the cases opportunities to visit the core University service laboratories were made available to the Trainees. These laboratory visits included the Histopathology Laboratory, Microarray Laboratory, Gene Sequencing and Synthesis laboratory, and the Proteomics Facility. In all cases following the visit to the laboratory, the students discussed the types of information obtained by these laboratories and the application of that information to their tutorial cases.

**Objective 4: Provide Trainees with an understanding of the clinical realities of breast cancer diagnosis and treatment.**

All Trainees were provided the opportunity to spend time with a histopathologist, a medical oncologist and his patients and view a surgery. Following each of these experiences, the Trainees discussed their responses and what they gained in understanding from the physician and the patients. It was evident to the faculty of this program that these clinical experiences had

an extremely powerful motivational effect on the students. These opportunities will be maintained in the program.

**Objective 5: Provide Trainees opportunities to learn about breast cancer research in the Health Science Center.**

Trainees were provided with an opportunity to visit breast cancer research laboratories within the HSC. These tours were not simply to view the facilities but each of the investigators or their research staff provided the students with a discussion of the question under investigation in the laboratory and how they were attempting to obtain answers. In addition, weekly breast cancer seminar series/journal club was developed in which the research mentors either discussed their individual research or discussed a seminal research publication. For these seminars the presenters were charged with formatting the discussion and presentation to the academic level of the Trainees. In addition, following the presentations the Trainees discussed their understanding of the presentation in the context of the tutorial meeting.

**Objective 6: Trainees will complete a research project in the laboratory of a funded breast cancer investigator.**

During the first two weeks of the program in an informal setting the Trainees were introduced to the research investigators and learned about the available projects. By the end of the two week period students selected a research project. Trainees worked on these projects during the duration of the summer. A portion of the tutorial sessions were devoted to Trainees discussing their successes and frustrations with their research and updating each other on their progress. The capstone experience of the summer was an opportunity for the Trainees to present the results of their research in a public forum.

**Objective 7: Trainees will learn to read and present the breast cancer literature critically.**

The summer breast cancer seminar series, described above, alternated with a journal club discussion in which the Trainees read and discussed breast cancer research literature. Students also had opportunities to practice both reading the literature and presenting the papers in the context of the tutorials. Students currently in and completing phases II and III of the program have also had an opportunity to present data at national meetings.

**Objective 8: Document satisfaction with the program and track student outcomes.**

Through out the summer, weekly "brown bag" discussions were held with the program director. Due to the constructive relationship built between the Trainees and the faculty, these discussions were candid and provided valuable feedback to the program director. The dates of these feedback sessions are listed in the program schedule. Information obtained from the Trainees was frank, professional and obviously aimed at improving the program. The clinical and laboratory tours as well as the tutorial experience were well received by all Trainees.

Trainee comments about their own learning, associated with these experiences, were some of the most positive comments ever received by the faculty. As described previously, 2 Trainees from the first year experienced difficulty with their mentors. These issues have been addressed with the faculty mentors and we did not experience similar problems with the second cadre of students.

Table 2 provides an assessment of the outcomes of the program for the first two groups of students.

<b>Student</b>	<b>Cadre</b>	<b>Graduation Date</b>	<b>Current disposition</b>
Student 1 (Adrian)	1	Spring 2003	Applied to UNM Medical School
Student 2 (Anna)	1	December 2003	Applied to UNM MD/PhD Program
Student 3 (Or)	1	Spring 2004	Accepted to Duke University, Biomedical Engineering Graduate Program
Student 4 (Louis)	1	Spring 2004	Accepted to Duke University, Biochemistry Graduate Program
Student 5 (Bridget)	1	Spring 2004	Accepted to UNM Biomedical Sciences Graduate Program
Student 6 (Laura)	1	December 2004	Senior in the Biology program
Student 7 (Raphaela)	1	Withdrew	Withdrew because of health issues. Currently working as a med lab tech.
Student 8 (Chantal)	2	Spring 2005	Biology senior participating in an NIH summer research program and continuing in phase II
Student 9 (Alexandra)	2	Spring 2005	Biochemistry senior – continuing in phase II
Student 10 (Guinevere)	2	Spring 2005	Biochemistry senior – continuing in phase II
Student 11 (Mitchell)	2	Spring 2005	Biochemistry senior – continuing in phase II
Student 12 (Mariza)	2	Spring 2006	Biology Junior – continuing in phase II
Student 13 (Stephanie)	2	Spring 2010	Withdrew from the program to apply to the UNM PharmD program.

### **Key Research Accomplishments**

- Development of a formal comprehensive experience for Trainees that focuses on breast cancer research.
- Developed a set of 6 guided inquiry cases to help Trainees learn about breast cancer biology and research skills and ethics.
- Developed a set of laboratory tours and clinical experiences to supplement the training program and provide additional motivation for the students to continue with their research.
- Developed a public research forum for the Trainees to present their research accomplishments.

### **Reportable Outcomes**

- Of the initial 7 students, 5 will have graduated by spring 2004 and these five are all continuing on a career path directed toward biomedical research.
- All but one of the second group of students are still actively involved in biomedical research.
- 4 students from the first cadre have reported their research results at national or local meetings.

**B. Holder, M. Bisoffi and J. K. Griffith (2003) Is there intra-tumor variability in telomere DNA content in human breast cancers? 2003 FASEB Experimental Biology Meeting, San Diego, CA.**

Structure and Kinetic Properties of Lactate Dehydrogenases from Four Species of Human Malarial Parasites. TA Vanderjagt, WM Brown, A Hoard, LA Hunsaker, LM Deck, RE Royer, RC Piper, J Dame, MT Makler, DL Vander Jagt.  
**FASEB J 17, A981 (2003)**

W.M. Brown, **L.E. Metzger**, J.P. Barlow, L.A. Hunsaker, L.M. Deck, R.E. Royer, and D.L. Vander Jagt, 17-Beta-Hydroxysteroid Dehydrogenase type1: Computational Design of Active Site Inhibitors Targeted to the Rossmann Fold, **Chem Biol Interact 143-144, 481-491 (2003)**

**Amit, O., Pan, S., Jiang, Z., Evans, L., Taylor, C., Gauntt, B., Wan, H., Chen, X., Omdahl, J. and Hu, C.-A., A. (2002) Genomic and proteomic studies of apoptosis in cancer cells. Inaugural Genomics Symposium, The University of New Mexico.**

### **Conclusions**

Based on the first cadre's graduation rate and career paths selected by the students, this program is considered successful. The second cadre of students is following a similar course of development. No changes are anticipated in recruiting, laboratory tours, clinical experiences, seminars or the tutorial. Considering that the current UNM graduation rate is approximately 50%, this program is judged as extremely successful and the faculty are currently investigating methods to make this program available to an increased number of students.

A component of the training program is a public service project designed by the trainees to increase public awareness of Breast Cancer Research or career possibilities. To address this issue the first year trainees elected to focus on the local UNM undergraduate community. The "Pathways" trainees this year formally chartered the UNM Undergraduate Biomedical Research Association to, which is designed to encourage undergraduate students to select biomedical research careers and support them in their academic careers. This is currently an active, formally chartered, UNM student organization. The students in the second year of the program have elected to continue supporting this research effort.

## **Appendices**

### **Appendix 1: Current advertising brochure**



#### **THE PROGRAM**

The Department of Biochemistry and Molecular Biology at the University of New Mexico School of Medicine provides full-time summer research opportunities for students entering their sophomore and junior year to conduct breast cancer research in the laboratory of a funded investigator for twelve weeks during June-August. Varied research topics are available to undergraduate students. The breast cancer research projects that trainees may pursue include:

- Development of new antimetastatic drugs
- Tumor suppressor gene function
- Mutational control of gene expression
- Mechanisms of cell death
- Mechanisms of tumor cell metastasis
- Nutritional control of gene expression
- Telomere biology

The program is supported by a training grant from the Department of Defense Breast Cancer Research Training Program. The purpose of the University of New Mexico Breast Cancer Research Training Program is to provide talented undergraduate students, especially students from under-represented Southwestern minorities, the experiences, tools, knowledge and motivation to pursue careers in breast cancer research. The Program includes classroom, clinical and research experiences that will provide a solid foundation for graduate studies and encourage the pursuit of careers in breast cancer research.

#### **DURATION AND FUNDING**

The program for undergraduate students offers full-time research experiences for twelve weeks during the summer with a stipend of \$4000. There is the possibility of continuation of students' research projects beyond the first summer.

#### **QUALIFICATIONS OF APPLICANT**

Sophomore and junior students curious about potential careers related to understanding the biology of breast cancer are encouraged to apply for the program. Applicants must have successfully completed general chemistry and general biology courses and be in good academic standing. Student trainees will be selected on the basis of their essay, transcripts, and letters of recommendation.

## **SPECIAL ACTIVITIES**

Participation in the program requires participation in one Research Retreat upon completion of their projects. Complete the information below and send with your completed application materials to:

## **HOW TO APPLY**

Applicants should submit: a one page essay describing why they are interested in the Undergraduate Breast Cancer Summer Research Training Program, a description of prior research experience, a transcript, and three letters of recommendation. And include contact information

Name:

Address:

City:

State:

Zip:

School:

Telephone:

E-mail address:

Send the above materials to:

## **PATHWAYS TO RESEARCH CAREERS**

Undergraduate Breast Cancer Summer Research Training Program

Department of Biochemistry & Molecular Biology

915 Camino de Salud, NE

Basic Medical Science Building, Room #249

University of New Mexico School of Medicine

Albuquerque, New Mexico 87131-5221

Application materials must be received no later than January 31, 2004.

## **REVIEW, NOTIFICATION, AND ACCEPTANCE**

Applications will be reviewed by an Advisory Committee. All applicants will be notified by April 1st of the results of the review process. Prospective trainees must affirm acceptance of their traineeship within 14 days of notification.

## **Appendix 2: List of tutorial cases and brief case objectives**

### **Case 1: Angie Landholm**

#### **Case Objectives**

- Student introductions
- Introduction to problem based learning
- Student identification of cancer related concepts

### **Case 2: Susan Murdahl**

#### **Case Objectives**

- Correlate cellular structure with normal structure and function of the breast and changes during pregnancy
- Normal and pregnant histology
- Mechanism of estrogen-dependent cellular proliferation
- Cell Cycle
- Apoptotic mechanisms

### **Case 3: Joyce Martinez**

#### **Case Objectives**

- Behavioral issues related to the diagnosis of cancer. How does the diagnosis of cancer affect the patient.
- Introduction to the vocabulary and concepts related to incidents of disease and relative risk.
- What is and what causes cancer: This should be a general discussion that relates back to the discussion of the cell cycle and apoptosis.
- Different kinds of cancer - vocabulary

### **Case 4: July Peters**

#### **Case Objectives**

- Epidemiology
- Steps in carcinogenesis
- Molecular Basis of Cancer

### **Case 5: Cancer Screening Tests**

#### **Case Objectives**

- Discussed the arguments supporting and rejecting mammography as a routine public screening program.
- Designed a public education program to increase breast cancer awareness.

### **Case 6: Doris Hernandez**

#### **Case Objectives**

- Staging of breast cancer
- Treatment options
- Experimental treatment options
- Community resources

### Appendix 3: Summer 2003 Pathways Schedule

	<b>Monday</b>	<b>Tuesday</b>	<b>Wednesday</b>	<b>Thursday</b>	<b>Friday</b>
<b>JUNE</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>13</b>
AM		<b>Oncology Clinic</b> 10:00: Group B A. Mangalik, M.D.	<b>Proteomics</b> 9:00 - Group B 10:00 -Group A	<b>9:00 Molecular Modeling</b>	<b>Histology Lab</b> 9:30: 3rd Floor Lobby N. Joste, M.D.
Noon	<b>Brown Bag, mentors</b>	<b>Pathways Seminar</b>	<b>Brown Bag, mentors</b>	<b>Brown Bag, mentors</b>	<b>Brown Bag, mentors</b>
PM	<b>Tutorial 1:00 - 4:00 Angie Landholm 305 BMSB</b>		<b>Tutorial 1:00 - 4:00 Angie Landholm 305 BMSB</b>		<b>Tutorial 1:00 - 4:00 Angie Landholm 305 BMSB</b>

	<b>June</b>	<b>16</b>	<b>17</b>	<b>18</b>	<b>19</b>	<b>20</b>
AM						
Noon	<b>Brown Bag, mentors</b>	<b>Pathways Seminar</b>	<b>Brown Bag, mentors</b>	<b>Brown Bag, mentors</b>	<b>Brown Bag - Program Assessment Griffith / Anderson</b>	
PM	<b>Tutorial 1:00 - 4:00 Susan Murdahl 305 BMSB</b>		<b>Tutorial 1:00 - 4:00 Susan Murdahl 305 BMSB</b>		<b>Tutorial 1:00 - 4:00 Susan Murdahl 305 BMSB</b>	

	<b>June</b>	<b>23</b>	<b>24</b>	<b>25</b>	<b>26</b>	<b>27</b>
AM						
Noon		<b>Pathways Seminar</b>				
PM	<b>Tutorial 1:00 - 4:00 Joyce Martinez 245 BMSB</b>		<b>Tutorial 1:00 - 4:00 Joyce Martinez 245 BMSB</b>		<b>Tutorial 1:00 - 4:00 Joyce Martinez 245 BMSB</b>	

JUNE	<b>30</b>	<b>1-Jul</b>	<b>2</b>	<b>3</b>	<b>4</b>
AM					
Noon		Pathways Seminar			
PM	Tutorial 1:00 - 4:00 <b>Julie Peters</b> <b>245 BMSB</b>		Tutorial 1:00 - 4:00 <b>Julie Peters</b> <b>245 BMSB</b>		

JULY	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>
AM					
Noon		Pathways Seminar			<b>Brown Bag - Program Assessment Griffith / Anderson</b>
PM	Tutorial 1:00 - 4:00 <b>Julie Peters</b> <b>245 BMSB</b>		Tutorial 1:00 - 3:00 <b>To Screen</b> <b>305 BMSB</b>		

JULY	<b>14</b>	<b>15</b>	<b>16</b>	<b>17</b>	<b>18</b>
AM					
Noon		Pathways Seminar			
PM	Tutorial 1:00 - 3:00 <b>To Screen</b> <b>305 BMSB</b>		Tutorial 1:00 - 3:00 <b>To Screen</b> <b>305 BMSB</b>		

<b>JULY</b>		<b>21</b>	<b>22</b>	<b>23</b>	<b>24</b>	<b>25</b>
AM						
Noon		Pathways Seminar				
PM	Tutorial 1:00 - 3:00 To Screen 305 BMSB		Tutorial 1:00 - 3:00 <b>Doris Hernandez</b> 305 BMSB			

<b>JULY</b>		<b>28</b>	<b>29</b>	<b>30</b>	<b>31</b>	<b>1-Aug</b>
AM						
Noon		Pathways Seminar				
PM	Tutorial 1:00 - 3:00 <b>Doris Hernandez</b> 305 BMSB		Tutorial 1:00 - 3:00 <b>Doris Hernandez</b> 305 BMSB			

<b>Aug</b>		<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>
AM						
Noon		Pathways Seminar				
PM						

AUG	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>	<b>15</b>
AM					
Noon		Pathways Seminar			<b>Brown Bag - Program Assessment Griffith / Anderson</b>
PM					

AUG	<b>12</b>	<b>13</b>	<b>14</b>	<b>15</b>	<b>16</b>
AM					POSTERS and PRESENTATIONS
Noon					
PM					